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Therapeutic Aspects and Composition of Camel Milk: A Meta-Analysis Study

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ABSTRACT

Camel milk (CaM) is not only considered as a food with high nutritive values but also a food with therapeutic functions that could be used to assist the patients with some of the diseases. These include the presence of peculiar antibodies that can penetrate into the cancerous tissues and the presence of insulin like molecules that could be used to treat diabetes, bioactive peptides that are produced from camel milk protein having antioxidant, antimicrobial and anti-hypertensive activity. Bovine's milk allergy is by far the most prevalent food allergy especially in children because of the presence of β-lactoglobulins. CaM lacks this protein and is enriched with α-lactalbumin such as human milk. CaM is very rich source of protein along with potential anti-microbial and protective activity while the fat present in the camel milk doesn't forms a layer so it is evenly distributed throughout the milk in the form of small globules when kept undisturbed which make its digestion easier. It contains higher concentration of long chain fatty acids (C14-C18) than the short chain fatty acids, so it is healthier. CaM has unique property to inhibit the growth of certain microorganisms because it contains protective proteins and enzymes with special antibacterial and antiviral properties such as lactoferrin, peptidoglycan protein (PGRP) and lacto-peroxidase. It contains insulin so used to treat the Diabetes mellitus. The amount of insulin (42μU/ml) is not so much higher than in cow's milk but this insulin is protective that is not destroyed in the stomach and passes to the intestine causing reduction in the blood sugar level. Camel immunoglobulin's have no short chains and small so are active against antigens. The camel's immunoglobulin's pass into the milk and so are available for combating autoimmune diseases. CaM can protect gastric mucosa against ulcers. It can be used in the treatment of tuberculosis as well. It has a handsome amount of lactose percentage which is

tolerant to the human beings so don't cause lactose allergy in the people. CaM is considered very special in this regard having SNF and total solids almost very near to cattle milk but considered healthier than cattle milk.

Keywords: Camel milk, diseases, immunoglobulin, composition, characteristics

INTRODUCTION

Growing awareness has changed the camel place in the livestock species; camel is considered a food animal with therapeutic worth now (Raziq *et al*., 2021; Faraz *et al*., 2019*a*). The dromedary camel is well known for its ability to produce milk (Faraz *et al*., 2019*b,c*). In Africa and Arabian Peninsula camels are used to produce milk and meat (Faraz, 2019*a,b*). In Asia and Africa its milk is known as food as well as remedy for 5000 years. So, it is not only a food rather than a medicine (Faraz, 2020).

Many studies reported its health benefits like it has rich concentrations of mono and poly unsaturated fatty acids (PUFA), lactoferrins, serum albumins, immunoglobulin's, lysozyme, vitamins C & E, magnesium and iron contents along with hormone insulin (Konuspayeva *et al*., 2009; Yadav *et al*., 2015). CaM could be used against the treatment of many diseases like stomach and intestinal disorders, diabetes mellitus and food allergies. It is also used to reduce the cholesterol level in the blood, to treat psoriasis, autism and tuberculosis disease. It is used for the healing of inflammation; reduce the growth of cancer cells, to strengthen the immune system of the body (Mohammadabadi and Faraz, 2021).

Definitely camel produces milk with lot of nutrient richness having the special qualities as CaM is very rich source of protein along with potential anti-microbial and protective activity (Wernery, 2006). The relative amount of the fat, protein and lactose components of CaM are very similar to those in the cow milk. In addition to that, the fat present in the CaM doesn't forms a layer so it is evenly distributed throughout the milk in the form of small globules which make its digestion very easier (Meena *et al*., 2014). It contains higher concentration of long chain fatty acids (C_{14}-C_{18}) thus it is healthier (Konuspayeva *et al*., 2008). It has unique property to inhibit the growth of microorganisms as it contains protective proteins and enzymes with special antibacterial and antiviral properties such as

lactoferrin, peptidoglycan protein (PGRP) and lacto-peroxidase (El-Agamy *et al*., 1992).

It contains insulin so used to treat the *Diabetes mellitus* (Agrawal *et al*., 2003). The amount of insulin (42µU/ml) is not so much higher than in cow's milk but this insulin is protective that is not destroyed in the stomach and passes to the intestine causing reduction in the blood sugar level (Wernery, 2006). According to Konuspayeva and Faye (2011), in Kazakhstan the camel milk and Shubat (fermented milk products) could be used as remedy in intestinal diseases. This literature review will pave the way for further investigations in this field and its health benefits should be studied in detail in future.

LITERATURE REVIEW

Camel Milk Composition

Fat and Protein

The color of CaM is an opaque white and it has a sharp taste with faint sweetish odor and sometimes may be salty (Kula and Tegegne, 2016; Abbas *et al*., 2013). Literature revealed that fat and protein percentages in camel's milk ranged between 2.4-5.5% and 2.5-4.5%, respectively (Kappeler 1998; Iqbal *et al*., 2001; Khan and Iqbal, 2001; Khaskheli *et al*., 2005, Alhadrami and Faye, 2016; Faraz *et al*., 2018; Faraz *et al*., 2020).

Alhadrami and Faye (2016) reported fat and protein percentage in CaM as 4.1 and 3.4, respectively. Faraz *et al.* (2018) reported fat and protein percentage as 4.4 and 3.4 in Marecha dromedary camel in Pakistan reared under extensive management system. In a very recent study, Faraz *et al*. (2020) studied the milk production and composition of Barela dromedary camel in Thal desert, Punjab Pakistan and reported fat and protein percentages as 4.26 and 3.62, respectively. Reported mean values for fat and protein percentages of Mauritanian camel's milk were 2.92±0.59 and 2.50±0.10, respectively (Meiloud *et al*., 2011).

Nagy *et al*. (2013) studied milk production of dromedary camels under intensive management in United Arab Emirates and reported average fat and protein concentrations as 2.51±0.03 and 2.60±0.01%, respectively. Kappeler *et al*. (1998) reported the camel milk fat as 3.8% and protein as 2.7-4.7%. The fat contents of camel's milk vary from 2.5-5.9% having a mean of 4.6%, which are slightly higher than those of cow's milk. Kebebew and

Baars (1998) reported the camel milk fat and protein contents as 4.2±1 and 3.0±0.6 percent, respectively in the Errer valley.

Mean values for fat and protein percentages were reported to be 3.57±0.09 and 2.85±0.036, respectively in Pakistani camels by Iqbal *et al*. (2001) and Khan and Iqbal (2001). Raziq *et al*. (2011) reported fat and protein percentages as 2.63% and 4.01%, respectively in Kohi camels in Balochistan. Elamin and Wilcox (1992) reported 3.15% fat and 2.81% protein in milk of Majaheim camels in Saudi Arabia. Reported fat and protein percentages were 3.22% and 2.91% in Majaheim, 2.85% and 2.52% in Hamra and 2.46% and 2.36% in Wadah camel's milk, respectively in Saudi Arabia (Mehaia *et al*., 1995). CaM was found to be less fatty than that of cow's milk so it is readily digested (Konuspayeva *et al*., 2008; Negate, 2002).

Konuspayeva *et al*. (2009) reported fat and protein percentage as 3.22 and 2.91. Mal (2006, 2007) reported ranges for fat and protein percentages as 2.60-3.20 and 3.73-3.89, respectively in Indian camel's milk. Mal and Pathak (2010) reported fat and protein percentages as 5.5% and 3.87%, respectively in Indian Bactrian camel's milk. Morin and Rowan (1995) reported fat percentage as 2.7% in Llama camel's milk in USA.

Lactose

Alhadrami and Faye (2016) reported lactose percentage as 3.7 in CaM. Faraz *et al*. (2018) reported lactose percentage as 4.82±0.04 in Pakistani Marecha camel reared under extensive management system. In a very recent study, lactose percentage was found to be 4.84 in the milk of Barela dromedary camel in Thal desert Punjab, Pakistan (Faraz *et al*., 2020). Kappeler (1998) reported lactose contents from 4.8-5.8 %. Guliye *et al*. (2000) reported lactose percentage as 4.81 in Bedouin camels; Konuspayeva *et al*. (2009) reported lactose as 4.46±1.03. Reported range for lactose percentage was to be 3.91-5.08 % in dromedary camel's milk in Pakistan (Iqbal *et al*., 2001; Khan and Iqbal, 2001).

Khaskheli *et al*. (2005) studied physico-chemical quality of camel milk and reported range for lactose as 2.9-4.12 gm/100 gm. Kamoun and Jemmali (2012) studied milk yield and characteristics of Tunisian camel and reported average lactose as 43.82±5.68 gm/L. Nagy *et al*. (2013) studied milk production of dromedary camels under intensive management in

United Arab Emirates and reported average lactose as 4.03±0.03%. Reported percentage of lactose was to be 4.16% in Majaheim camel's milk in Saudi Arabia (Elamin and Wilcox, 1992). Mehaia *et al*. (1995) reported 4.43% lactose in Majaheim, 4.46% in Hamra and 4.44% in Wadah camel's milk, respectively in Saudi Arabia. Reported mean value for percentage of lactose was to be 4.91±0.61% in Mauritanian camel's milk (Meiloud *et al*., 2011). In Saudi Arabia, Soffer breed, first stage of lactation and semi nomadic system showed highest concentration of lactose while this value has been decreased by subsequent parity (Aljumah *et al*., 2012).

SNF & Total Solids

SNF and total solids percentages in CaM ranged between 8.9-14.3% and 11.5-17.8%, respectively. Alhadrami and Faye (2016) reported SNF as 8.9% in camel's milk. Faraz *et al*. (2018) reported SNF and total solids percentages as 8.96 and 13.38 in Marecha camel milk in Pakistan. In a very recent study, Faraz *et al*. (2020) investigated the milk yield and composition of Barela dromedary camel in desert Thal Punjab, Pakistan and reported SNF and total solids percentages as 9.02 and 13.28, respectively. Mean values for SNF and total solids percentages were reported to be 9.00±0.13 and 12.36±0.19, respectively in Pakistani camels (Iqbal *et al*., 2001; Khan and Iqbal, 2001).

Elamin and Wilcox (1992) reported 7.8% SNF and 10.95% total solids in milk of Majaheim camel in Saudi Arabia. Reported SNF and total solids percentages were 8.13% and 11.35% in Majaheim, 7.78% and 10.63% in Hamra and 7.61% and 10.07% in Wadah camel's milk, respectively in Saudi Arabia (Mehaia *et al*., 1995). Mal et al. (2006) and (2007) reported ranges for SNF and total solids percentages as 7.25-8.25 and 9.85-11.45, respectively in Indian camel's milk. Reported SNF and total solids percentages were to be 9.18% and 14.68%, respectively in Indian Bactrian camel's milk (Mal and Pathak, 2010). Meiloud *et al*. (2011) reported mean values for SNF and total solids as 8.88±0.08 and 11.80±1.0 in Mauritanian camel's milk. Soffer breed, first stage of lactation and semi nomadic system showed highest concentrations of SNF and total solids while these values have been decreased by subsequent parity (Aljumah *et al*., 2012).

Minerals

Alhadrami and Faye (2016) reported ash percentage in terms of minerals as 0.7% in CaM and specific concentration of calcium, phosphate, copper, iron, magnesium, manganese, sodium and zinc were to be 1060.0-1570.0, 580.0-1040.0, 13.0-1.8, 1.3-2.5, 75.0-160.0, 0.1-0.2, 360.0-620.0 and 4.0-5.0 mg/L in CaM.

Kappeler *et al*. (1998) reported the camel milk calcium, phosphorus and iron as 1000-1400 mg/ml, 0.650-1.10 mg/L and 0.3-0.8 mg/L, respectively. While average values for mineral composition were reported to be 49.42, 15.04, 0.55, 0.07, 0.22 and 1.42 mg/100gm of Na, Mg, Fe, Mn, Cu and Zn, respectively in milk of Pakistani Kohi camels (Raziq *et al*., 2011). Elamin and Wilcox (1992) reported mineral contents as Ca (30.03), K (72.48), Mg (4.50), Na (43.10), Fe (0.28) and Pb (0.18) mg/100g in milk of Majaheim camels in Saudi Arabia. Reported mean values for Ca, Mg and P were to be 120.6±16.6 mg%, 11.2±2.0 mg% and 82.1±10.4 mg%, respectively in South Morocco camels (El-Khasmi *et al*., 2001).

Onjoro *et al*. (2003) reported range of Ca, Mg and P as 74.1-200.2 mg%, 5.9-115 mg% and 2.1-92.9 mg%, respectively in Somali camels. Reported mean values for Fe, Cu and Zn were to be 1.00±0.12, 0.44±0.04 and 2.00±0.02, respectively in Indian dromedary camels (Singh *et al*., 2006). Camel milk contains higher values of trace minerals such as Fe, Zn and Cu as compared to bovine's milk (Mal *et al*., 2006 and 2007). Mal and Pathak (2010) reported Ca and P of Bactrian camel's milk in India as 0.11 and 0.09 percent, respectively. Meiloud *et al*. (2011) reported mean value for mineral contents in Mauritanian camel's milk as 1.30±0.09. Aljumaah *et al*. (2012) determined the factors like breed and production system that altered the milk composition of dromedary camels in Saudi Arabia and reported that Ca and K values were higher in Maghatier breed and in semi nomadic system.

Vitamins

A very few data about vitamins of CaM are available. It appears that vitamin A; E, thiamin, folic acid, riboflavin and pantothenic acid contents are lower in CaM than cow's milk. Pyridoxine and cyanocobalamin contents are almost same. The contents of niacin and vitamin C are substantially higher than cow's milk.

CaM has a higher level of Vitamin C and equal or higher levels of vitamins B1 and B12 than milk of other domestic animals (Konuspayeva *et al*., 2011) and this high level of vitamin C is especially important for the nomadic pastoralists as they face rarity of fruits and vegetables. Alhadrami and Faye (2016) reported vitamins concentration as Retinol (A) 0.10-0.15, Thiamin (B1) 0.33-0.60, Riboflavin (B2) 0.42-0.80, Pyridoxine (B6) 0.52, Cobalamin (B12) 0.002, Niacin 4.6, Folic acid 0.004, Pantothenic acid 0.88, Tocopherol (E) 0.53 and Ascorbic acid (C) 24-36.

Health Effect of Camel Milk

Gastrointestinal Disorders

There are anti-inflammatory proteins present in CaM which has a positive effect on intestinal disorders and stomach problems. Vitamin rich composition and the presence of mono and polyunsaturated fatty acids improve carbohydrate metabolism in the body (Karray *et al*., 2005; Konuspayeva *et al*., 2008). Angiotensin-I converting enzyme (ACE) is found in camel milk which facilitate the digestion of milk proteins in a better way (Alhaj *et al*., 2006; Quan *et al*., 2008). CaM has special anti-diarrheal properties, as it performs the normal bowl movements in the intestinal tract and is rich in anti-rotavirus antibodies so are used to treat the diarrhea especially in the children (Yagil, 2013).

Sugar Diseases

Diabetes mellitus leads to increased blood sugar levels called hyperglycemia. A metabolic disorder which can be treated by camel milk (Agrawal *et al*., 2007; Al-Haj and Al-Kanhal, 2010; Malik *et al*., 2012). Type-1 diabetes is caused by deficiency of insulin hormone due to the destruction of insulin producing beta cells in the pancreas. As CaM has protective insulin which is not degraded in the stomach, passes directly to the intestines thus, reducing the blood sugar levels (Sahani *et al*., 2005; Khan *et al*., 2013). Consuming CaM cause reduction in the insulin doses required (Agrawal *et al*., 2011). Research studies showed that CaM has improved the function of liver and kidneys in diabetic rats (Hamad *et al*., 2011; Shori, 2015).

CaM has higher concentrations of insulin (58.67±2.01 UL) as compared to cow's milk (17.01±0.96 UL) (Hamad *et al*., 2011; Mullaicharam, 2014) and IGF-I (insulin like growth factor) which is not destroyed in the stomach, remains

unaffected by gastric acid so passed to the intestine, absorbed and reduces the blood glucose levels (El-Khasmi *et al*., 2002; Zagorski *et al*., 1998). CaM has marvelous effects in reducing the blood glucose levels and insulin requirements so it limits the diabetic complications like elevated cholesterol levels, liver and kidney problems, decreased oxidative stress and delayed wound healing (Shori, 2015). CaM could be considered as option for the patient's intolerance to lactose (Cardoso *et al*., 2010). Mullaicharam (2014) reported that lactose intolerant patients can easily digest CaM and this lower lactose intolerance could be linked to the higher concentrations in L-Lactate in CaM which are reverse to cow milk as that is rich in D-Lactate (Baubekova *et al*., 2015).

Food Allergy

Some foods like milk and dairy products can cause allergy especially in the children, CaM is used to treat these food allergies (Shabo *et al*., 2005; Elagamy *et al*., 2009; Al-Hammadi *et al*., 2010). Elagamy *et al*. (2009) reported that IgE of children who are allergic to cow's milk, only unreacted with CaM. It is believed that immunoglobulins in CaM play a key role in reducing allergic symptoms in children (Shabo *et al*., 2005; Ehlayel *et al*., 2011). The children with cow's milk allergy could safely take camel milk as an alternative nutrient (Kaskous, 2016).

High Cholesterol

Increased levels of cholesterol are major risk factors for heart diseases. Administration of fermented CaM has hypocholesterolemic effects in rats as reported by Elayan *et al*. (2008). Hypocholesterol mechanism of CaM is unclear still and there is need to be future research studies on it. Li and Papadopoulos (1998) reported different hypotheses, as the interaction between bioactive peptides in CaM and cholesterol levels, which lead to cholesterol levels lowering in the blood. Rao *et al*. (1981) reported that the orotic acid present in CaM which arises as an intermediate in the metabolism of nucleic acids, is considered responsible for the lowering of cholesterol levels in rats and in humans (Buonopane *et al*., 1992).

Psoriasis and Hepatitis

CaM has considerable effects in the treatment of Psoriasis as it has a pleasant cool effect, reducing discomfort and itching and decrease skin redness and dryness (Wernery, 2006). For HCV many Egyptian

patients use CaM as traditional medicine which contains lactoferrin protein. Redwan and Tabll (2007) reported that the direct interaction between HCV & camel lactoferrin leads to a complete virus entry inhibition after seven days of incubation. Konuspayeva *et al*. (2006) reported that CaM has higher concentrations of lactoferrin which is considered as primary biotechnology drug against HCV infection (Redwan and Tabll, 2007).

El-Fakharany *et al*. (2012) documented that not only lactoferrin but also the camel IgG have the ability to recognize HCV peptides with a mark able titer in comparison to human IgG. Saltanat *et al*. (2009) reported that CaM has remarkable influence on the immune response in case of hepatitis B patients as it can inhibit the replication of virus DNA and thus promotes the recovery of chronic hepatitis B.

Cancer

Majeed (2005) reported that drinking of CaM causes reduction in the growth of cancer cells. Different scientists have checked the effects of CaM and it has found successful regarding single doses in rats. So, leukemia (blood cancer) could be treated with higher success rate with CaM. This can also be used to treat liver, lung and breast cancer as well. Korashy *et al*. (2012) reported that CaM significantly inhibits human hepatoma (HepG2) and human breast (MCF7) cells proliferation through the activation of both the extrinsic and intrinsic apoptotic pathways. Habib *et al*. (2013) evaluated the potential of CaM lactoferrin very first time and reported that it has the ability to inhibit the proliferation of colon cancer cell line.

Autism

Autism is funded by the opioid peptides (Dettemer *et al*., 2007). Incomplete metabolism of casein proteins in the intestine of people causes the formation of short neuroactive peptides, such as β-casomorphins which are major risk factors for autism (Woodford, 2011). Generally, the autism is an autoimmune disease, which surprisingly reaches the intestine not the brain (Schoenfeld *et al*., 2000). Ultimately the reactions in the intestines begin with diarrhea and effect on appetite of the patient. Al-Ayadhi and Elamin (2013) documented that CaM has a therapeutic effect in the Autism disease as it does not contain the two caseins that lead to the autism symptoms. Shabo and Yagil (2005) and Yagil (2013) also reported the fruitful effects of CaM against autism.

Al-Ayadhi and Elamin (2013) documented the effects of CaM on oxidative stress in autistic children and found that it can play a significant role in reducing oxidative stress and improve the behavior of affected children. Wernery *et al*. (2012) reported that autistic children have better social conditions, a reduction in hyperactivity, increased vigilance and regular bowel movements after consuming the CaM. Recently, (Adams, 2019) an American author wrote a book named "Camel Crazy: A Quest for Miracles in the Mysterious World of Camels" in which she told about the true story of her son, how he gets benefits from CaM for the cure of his autism, and she admired the CaM and reported that this may be used for the treatment of autism.

Immune System and Tuberculosis

Elagamy *et al*. (2009) reported that the proteins of CaM have unique and different patterns than cow and human milk. This lack of immunological similarity may be considered as an important criterion of the nutritional physiological and clinical aspects. CaM leads to improve immune function as it can protect other pathogens and better against external agents (bacteria or viruses).

There are special immunoglobulin's present in CaM as these are same in structure as of humans but only tenth in the size so this special attribute enables its targeting and penetration for destruction where human immunoglobulins cannot (Mullaicharam, 2014). Mal *et al*. (2006) reported that in India when CaM was supplemented @ 1 liter/day to patients of Tuberculosis there was no cough, chest pain, sputum and patients had improved appetite and body weight gain. The exact source of this is not investigated yet (Wernary and Yagil, 2012); hence, future research studies should be done in this regard.

Conclusion

CaM has not only the ideal composition to be calling it a complete food for infants as well as it is of great importance regarding the therapeutic indices. It can be used very safely for the children and people having allergies and lactose intolerance as it plays a pivotal role in the treatment of many diseases in different areas of the world. It is being used to treat diabetes, food allergies, cancer, hepatitis B & C, autism, psoriasis, high cholesterol, gastrointestinal disorders, strengthen the immune system, tuberculosis and joint problems. As the people getting

awareness about it, the CaM is going to be peculiar diet among people of the world. It is the need of time to recognize its importance among the farm animals and to make it "a future food animal" from the notion "ship of the desert". And at last, but not the least it is very important to secure our indigenous genetic resource for the purpose to meet with food security plans as CaM has composition very similar to that of cattle milk but with additional properties so its use should be encouraged among people.

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